DEVELOPMENT AND TESTING OF MID-ELEVATION, COMMERCIAL-TYPE, ANDEAN CLIMBING BEANS

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INTRODUCTION

Climbing beans have been an important component of traditional societies for centuries most often grown in intercropping but also as monocultures. In pure stands and in the tropics, climbing beans have among the highest yield potential of any beans especially as compared to more commonly grown bush beans. Climbing beans have expanded in certain areas of Africa but contracted in certain areas of Latin America, while in both continents production has switched from intercropping to monoculture. Climate change and changes in agriculture pose risks to the production of climbing beans but also provides challenges. A principal challenge has been the production of new well-adapted, high-yielding varieties for higher temperature environment and for monocrop systems of staking or trellising. Most currently-available climbing beans come from high-altitude areas of Central and South America and do not grow well in lower elevations or hotter climates. Currently, there are also very few climbing bean varieties with the red mottled or red kidney seed types that are preferred in many areas of the Eastern Africa and South America. Therefore, an additional challenge for breeders is to develop climbing bean varieties that produce grain with the proper color and size. Our research has addressed this by developing and testing commercial type climbing bean varieties that are adapted to monocropping and to lower elevation (800 to 1800m) production systems in Latin America and Africa.

MATERIALS AND METHODS

We developed a set of 62 mid-altitude climbing beans from various climbing bean x bush bean crosses and by selection for heat tolerance over four generations of pedigree selection (F2 to F6). The selections were coded as MAC (mid-altitude climbing) bean lines in the F7 generation. Of the selections, 27 were red mottled seeded, 13 were large-red and 32 were cream mottled, all with average seed sizes around 50 g / 100 seed. Yield data was collected at trials across two sites in Colombia for 55 MAC lines (Darien at 1450 masl and Palmira at 1000 masl) and across two sites in Uganda for a set of 11 MAC lines (Namulonge at 1150 masl and Kachwekano at 1830 masl). In addition, several MAC lines have been entered into national yield trials in Kenya (MAC13, MAC34 and MAC64). Testing of these genotypes in Colombia and Uganda has been conducted during the rainy seasons with randomized complete block design experiments. G685, G2333, G2337, ICA Viboral and Calima Darien were used as checks in the experiments in Colombia while in Uganda three previously released climbing beans, NABE 8C, NABE 9C and NABE 10C, were used as checks. Experiments in Palmira were protected from insect damage (primarily Empoasca, Epinotia, Thrips and Mites), while the experiments in Darien had preventative fungicide treatment at planting and again at flowering. The climbing beans were supported on bamboo and wire trellises in Colombia and by staking material in Uganda. Data collected in Colombia included yield per plant (Y/P), pods per plant (P/P), grain per plant (G/P), days to flowering (DF), days to maturity (DM) and harvest index (HI) based on stem and pod weight. Agronomic adaptation (AA) and climbing ability (CA) were evaluated on 1 to 9 scale (where 1=good and 9 = poor). Plant height (PH), raceme length (RL), number of pods per raceme (NP), pod length (PL), number of vines per guide (NV) and internode length at a height of one meter above the ground (IL) were evaluated for two plants per row and averaged to produce plot values. Data collected in Uganda included yield in kg/ha, days to flowering and days to maturity.

RESULTS AND DISCUSSION

The analysis of variance for the experiments conducted in Colombia showed that genotype and location effects were significant for all the traits measured while GxE effects were observed for all traits except for pods per plant (Table 1). This showed that climbing bean agronomic traits are sensitive to environmental conditions at the different altitudes represented by the sites in Colombia, something which has been frequently observed but rarely quantified. Among the control genotypes, high-elevation Andean climbers (ICA Viboral, Calima Darien) yielded almost nothing in Palmira and even suffered from poor adaptation at a mid-elevation site like Darien while Mesoamerican climbing bean check varieties, G685, G2333, G2337, had problems of adaptation in the hot seasons that occurred in Palmira. Meanwhile many of the advanced MAC lines outperformed these checks in Palmira, indicating a higher level of heat tolerance in these genotypes compared to G2333 and G685 which are standard varieties for climbing bean areas of Eastern Africa and to ICA Viboral a standard variety grown in Colombia. In Uganda, an AMMI biplot analysis of yields for the MAC lines shows the stability of several genotypes compared to previous climbing bean releases and their adaptation to the lowland site of Namulonge versus the highland site of Kachwekano (Figure 1). The majority of the climbing beans in both environments matured in 100 to 140 days from planting depending on the altitude of the test site with earliest maturation times in the lower elevation sites compared to the higher elevation sites.

In conclusion, these trials have given us a new appreciation of the multiple characteristics that make up a good climbing bean variety and the sensitivity of climbing beans to genotype x environment interaction. These elements are being factored into further breeding of mid-altitude climbing beans. In addition, disease resistance is being incorporated into MAC lines to counteract the greater prevalence and effect of virus infection at mid altitude sites. Several MAC lines have been or are planned to be release as varieties in Colombia, Kenya and Uganda. Rapid adoption of MAC13 through participatory varietal selection has been observed in Colombia and Kenya while yield increases and increased market opportunities for farmers growing MAC31 (released as NABE12C) has been observed in Uganda.

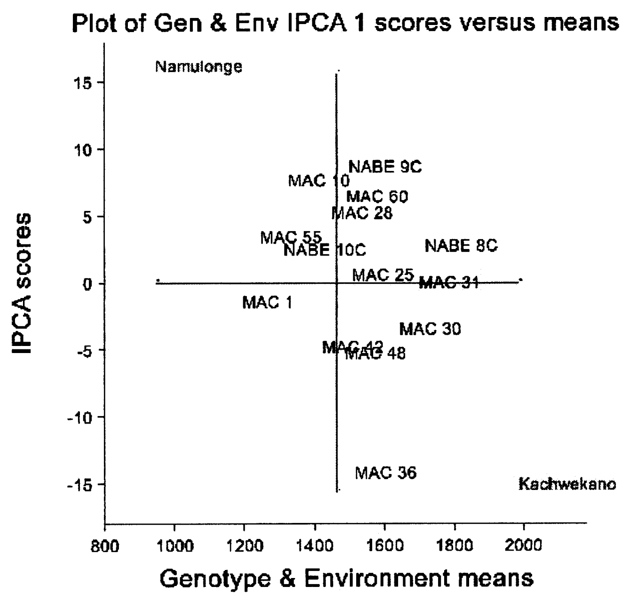

Figure 1. AMMI biplot of 11 MAC climbing bean lines evaluated for plot yield in two sites in Uganda.

Table 1. Significance (F statistic) of location, genotype and genotype x location effects in the trials for 55 MAC climbing bean lines in two sites in Colombia.

Source:	1.1.	P/P	Y/P	AA	CA	PH	DM	IL
Rep(loc)	2	0.7 ns	1.13 ns	0.25 ns	0.93 ns	0.64 ns	0.09 ns	0.24 ns
Loc	1	192.85 ***	469.14 ***	745.87 ***	86.98 ***	264.35 ***	5.41 *	36.49 ***
Trt	54	1.58 *	2.42 ***	8.79 ***	1.78 **	2.33 ***	3.17 ***	2.65 ***
Loc x Trt	54	1.33 ns	2.04 ***	5.9 ***	1.18 ns	1.5 *	1.62 *	1.15 ns

Significance at P=<.001 (***), .01 (**), .05 (*) or not significant (ns), indicated.

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